ASTRONAUTICS

Journal of the American Rocket Society

Number 39 **January, 1938**

Courtesy of UFA

Pictorial Highlights of Rocketry—Beginnings of an album of historical photographs. **"Cosmecology" and the Rocket**—An unknown world awaits exploration. **The Rocketor's Workshop** — Rocket fuel tanks.

Notes and News

MEETINGS ARE IMPORTANT; yet for some reason many members fail to attend them. Points out President Africano:

"Members who attend meetings regularly, by talking to other members about their various ideas and experiments, become familiar with rocket test technique and are more likely to be invited to attend and assist in the important field tests being planned for the coming season."

MANY NEW EXPERIMENTS are being planned. Mr. James Wyld has completed a new regenerative motor. Mr. John Shesta, chairman of the Society's Experimental Committee, reports that the new proving stand is nearly ready. It will have numerous refinements, including enlarged capacity, start and stop control, insulated oxygen tank, automatic recording thrust register. The latter item partilarly is a contribution of Mr. H. F. Pierce, who has worked with Mr. Shesta on the design of the equipment. Several new type motors are already scheduled for tests, along with actual rocket flights. There is much interest in designs of meteorological rockets fulfilling the nine specifications outlined in Astronautics No. 28.

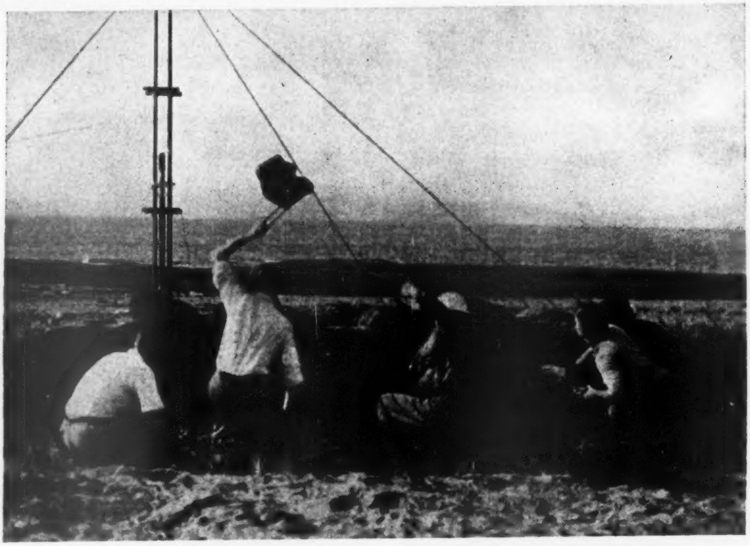
LATEST of educational institutions to join the rocket research procession is California Inistitute of Technology. Frank J. Malina of the Daniel Guggenheim Aeronautical Laboratory of California Institute, in collaboration with

(Continued on Page 16)

CONTENTS

*The technical parts were by Hermann Oberth, German experimenter. The movie was first shown in this country under the auspices of the American Rocket Society (then called American Interplanetary Society) on the evening of January 27, 1931, at the American Museum of Natural History. So many came, there was a small riot; the show had to be given twice.

ASTRONAUTICS, official publication of the American Rocket Society, is devoted to the scientific and engineering development of the rocket and its application to problems of research and technology. Published quarterly (January, April, July, October) by the American Rocket Society, 420 Lexington Avenue, New York City. Subscriptions with Associate Membership, $3 per year. **Editor, G. Edward Pendray.**



ZERO HOUR: ARS Rocket No. 4 about to begin its most spectacular flight, at Great Kills, Staten Island, September 9, 1934. Designed by John Shesta, it set the present speed record of 700 miles per hour. In the foreground trench (left to right) is shown Alfred Best throwing the ignition switch; Carl Ahrens waving the starting flag, John Shesta preparing to pull the valve release, G. Edward Pendray timing the shot. The rocket went out to sea; was rescued by boat.

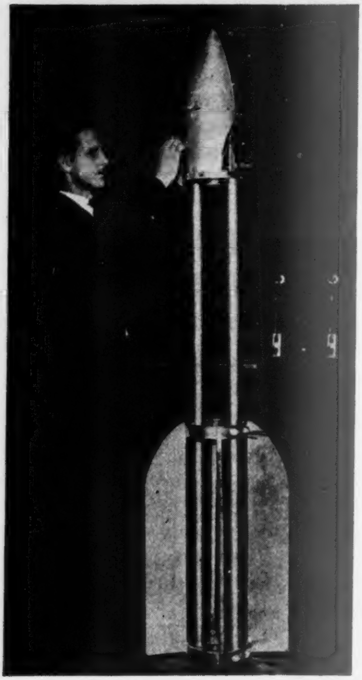
PICTORIAL HIGHLIGHTS OF ROCKETRY

Beginnings of a Photographic Album for Rocket Experimenters

HUNDREDS of photographs of rocket experiments have been made in various parts of the world; some have appeared here and there in rotogravure sections and magazines; some have been circulated from experimenter to experimenter, with words of explanation to illustrate a point or illumine an experience. But so great is the cost of reproducing photographs for small circulation, few of these valuable, important pictures have been generally available to experimenters for study and analysis. This is a great loss: as a famous editor is said to have remarked, a picture is worth a million words.

The Directors have authorized the publication in **Astronautics** of some of these historical pictures, so far as funds permit and the interest of members warrants.

Our cover picture, and the photographs on pages 3 to 7 of this issue, are the result. Whether further sections of "Rocketry's Picture Album" can be attempted will depend largely on whether members and subscribers like the idea, and write to tell us so.



ARS Rocket No. 1

CONSTRUCTED jointly by Mr. H. F. Pierce and Mr. G. Edward Pendray.

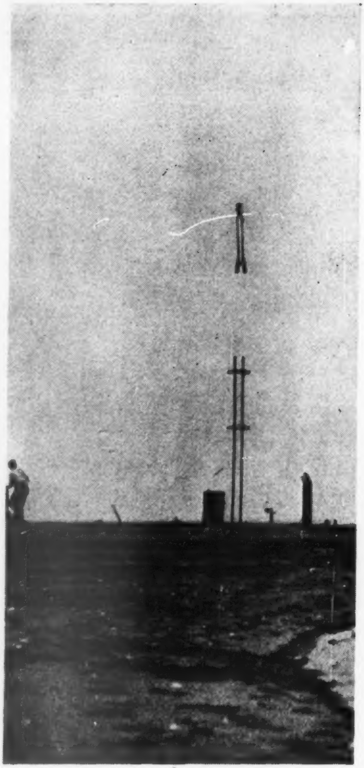
Oxygen and gasoline were carried in cylindrical tanks; the water-cooled motor was supported between them at the forward end of the rocket.

This rocket was tested November 13, 1932 at a field near Stockton, N. J., where members of the Society labored for several week-ends to prepare a suitable launching place, with bomb-proof trenches. On a static firing test the motor developed a thrust of approximately 60 pounds, burned more than 20 seconds without injury.

No actual flight test was made.

Upper photo shows the field at Stockton; in the foreground, Miss Lee M. Gregory and the shelter-trench. Near the launching rack are H. F. Pierce and David Lasser, then president of the Society. Photo at left shows Mr. Pierce and the rocket.

Both photos by Acme Newspictures.



ARS Rocket No. 2

FIRST FLIGHT of a rocket sponsored by the Society was that of ARS No. 2, constructed by Mr. Bernard Smith from parts of ARS No. 1 (see page 4). Mr. Smith brought the tanks closer together than in No. 1, clamped the motor between them, dispensed with the water-jacket, omitted the parachute, made balsa-wood fins to replace the earlier metal ones, and greatly simplified the construction throughout.

A preliminary test proved the rocket in good working order, and the shot (photo at left) took place immediately afterward, on May 14, 1933, at Marine Park, Staten Island.

The rocket shot disconcertingly toward a collection of wooden beach-houses down the shore, but fortunately exploded in midair before it reached them.

Lower picture shows the dugout just before the shot. Left to right: Alfred Best, G. Edward Pendray, Bernard Smith.

Photo at left by Acme

Gerhard Zucker

THIS YOUNG GERMAN experimenter made several attempts to establish rocket mail lines in England in 1934; unfortunately, some shots were unsuccessful. Powder rockets were used.

At left, Herr Zucker is shown sliding one of his rockets into a launching rack at Hants, on the Isle of Wight, on December 25, 1934. Before this shot could be completed, it was stopped by the police. Herr Zucker hadn't obtained official permission.

His most ambitious effort was a proposed shot from Harris to Scarp, in the Western Isles, Scotland. The spectacular, heartbreaking explosion that followed is shown in the photo above. It occurred on July 31, 1934.

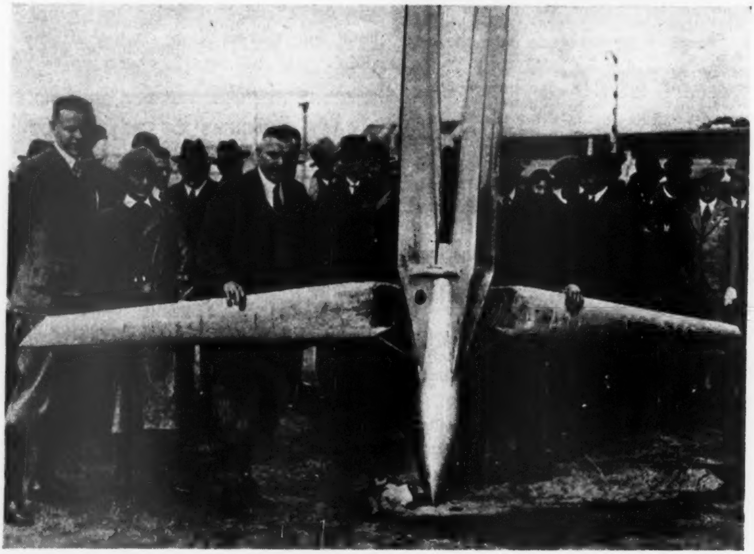
Reinhold Tiling

WITH DRY FUEL ROCKETS of new design, Herr Reinhold Tiling startled the world of rocket experimenters on April 15, 1931, by announcing that he had shot to an altitude of 6,600 feet at Osnabrueck, Germany.

Tiling's most important contribution was a system of large guiding vanes that became wings at the height of the flight, bringing his rockets down gently with a spinning motion.

The rockets were excellently designed for straight, vertical flight, as the Acme Newspictures photo on the right shows. Photo below depicts Tiling and one of his rockets, with two of the vanes outstretched in their descending position.

The use of dry fuels proved disastrous to Tiling. To the great loss of rocketry, he was killed in 1933 in an explosion at Osnabrueck, together with two assistants, and his notes and records were destroyed.



Letters to the Editor

MR. S. P. FERGUSSON, research associate of the Blue Hill Observatory at Hyde Park, Mass., makes some interesting comments on his altitude weather instrument, a description of which was recently reprinted (**Astronautics**, No. 38) from the June, 1920, **Monthly Weather Review.** Writes Mr. Fergusson:

> **The instruments suggested in that paper are suitable perhaps only for moderate heights—say to about 30 kilometers—particularly the pressure-elements, for the scale of pressure is so small above this height that other means are desirable. Also, during the seventeen years since 1920 many important improvements in instruments and technique have been accomplished and it may be that the apparatus of 1920 is only of historical interest.**
>
> **At this time, Blue Hill Observatory has placed in use a radio-meteorograph costing about $20, which, carried by a small balloon, sends down data of temperature and pressure which are recorded on a special chronograph at the ground; the data are immediately available for current use in weather-forecasting, etc. The Weather Bureau is using this instrument in daily ascensions at the Boston Airport and it is likely to replace the airplane as a means of sounding the atmosphere well into the stratosphere . . . It seems possible that a radio-instrument could be designed for use with the rocket.**

The radio-meteorograph mentioned by Mr. Fergusson is described in detail in the **Bulletin of the American Meteorological Society** for March, 1937, pp. 99-126.

AN ELECTRICAL WEATHER INSTRUMENT capable of "speaking" quicker than any mechanical device so far suggested, is proposed by Mr. Nathan Carver, of New York, who recently outlined the idea at a meeting of the Society and followed up with this communication to **Astronautics:**

> **The limiting factor in the rate of descent of a weather rocket is the time-lag of the barometer (which is inaccurate if the wind blows against it) and the mass of the thermometer elements, which do not at once record differences in temperatures. Further, any vibration or accelerative movements are causes of inaccuracies in recording instruments.**
>
> **I propose to overcome these difficulties by reading temperature, humidity, etc., directly from the condition of the atmosphere, by recording changes in a dielectric (which is the air itself between condenser plates). To eliminate the various variable factors, I believe we can beat one oscillator against the other, the difference being that the dielectric of one condenser remains the same, while that of the other changes as the state of the atmosphere changes. The condenser plates can be of almost any shape, with perforations or shaped holes.**
>
> **It can be readily seen that as long as all factors but one are exactly the same on both sides of the balanced oscillators, only the differing factor will be read in the form of a beat note at the oscillator frequency. Instead of carrying recording instruments in the rocket, all recording instruments could be on the ground.**

Mr. Carver is now planning to design and experiment with apparatus of this kind, to see whether it can operate effectively under the conditions of rocket flight; whether the weight can be kept low enough, etc.

BACK NUMBERS OF ASTRONAUTICS are in such demand that the Board of Directors has been forced to readjust the prices at which the Society's library may sell the meagre supply remaining in its files. This was done to conserve these valuable old copies as far as possible for the future use of serious experimenters. Beginning February 1, the price-scale will be: copies of the current year, 75 cents each; Numbers 18 to 38, inclusive, $1 each; Numbers 11 to 17, inclusive, $2 each; all earlier numbers, $5 each. The Library file contains only a few of each number from 11 to 17; of those earlier than 11, almost all are gone.

"COSMECOLOGY" AND THE ROCKET

An Almost Unknown World Awaits Exploration In The Sky

By PETER VAN DRESSER

SINCE the birth of the modern science of astronomy, the earth has been pictured as a spherical body isolated in space by millions of miles of vacuum. This vacuum has long been conceived as utterly "dead" save for radiations of heat and light which cross it, and the all-pervading action of gravitation. This picture has made it possible to draw a sharp distinction between celestial and terrestrial phenomena—except in the case of one or two bothersome borderline phenomena such as meteors which refuse to be clearly classified.

Indirect Evidence

In the past few decades this picture has changed considerably. Aviation has given us the ability to penetrate outward from the earth in some degree (however insignificant from the astronautical point of view!) and has made us aware of ever loftier regions for exploration and study. Meteorology, in its search for the causes of weather, has probed constantly higher into our atmosphere and has discovered unsuspected activity at enormous altitudes. Geophysics, in its study of earth magnetism, auroral activity, atmospheric electricity, and the like, has followed clues leading far into outer space. And lastly, astrophysics in its investigation of solar radiation, and cosmic rays, has brought celestial affairs much closer to earth, revealing unsuspected links between them and what were once thought to be purely terrestrial affairs.

As a result of these researches, it is no longer possible to think of the earth as a body surrounded by an insignificant film of air and lost in a dead sea of nothingness. Actually it is surounded by an envelope of magnetic, electronic, electrical and physical activity reaching out thousands, even hundreds of thousands of miles in all directions. The processes which occur within this envelope are as much celestial as they are terrestrial, since they are the result of the interaction of radiations and emanations from the sun, moon and galactic space itself, with the rarified outer limits of the earth's atmosphere, its magnetic and gravitational field, etc. The results of this interaction offer a tremendously fertile field for many types of research; not only so but they are tied up with many important phenomena on the earth's surface—such as weather and climate in general, and even the vital processes of the animal and vegetable world.

A Word Is Born

The rapidly increasing body of knowledge dealing with this intermediate zone cannot be classified under any established science — it belongs neither to geophysics nor astrophysics, nor yet to meteorology. To meet this difficulty, Dr. Harlan Stetson, astronomer and geophysicist, has coined the name **Cosmecology**, which means the study of the earth's cosmic environment. There is obviously a very close connection between the development of this science and that of rocketry. Most of the phenomena which it must study lie far beyond the range of even the most buoyant sounding balloons, and the scientists who have worked in this field have been obliged to rely on indirect methods.

These indirect methods include: Spectroscopic study of auroras, meteor trails, and sunlight. Triangulation of

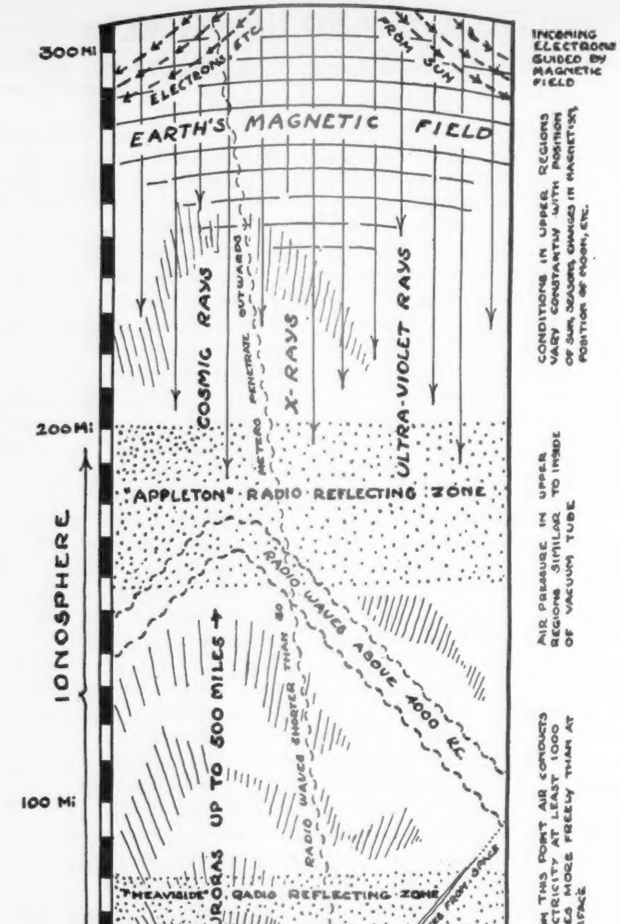


Fig. 1. Cross-section of the earth's atmosphere

the heights of meteors, auroras, and various high-altitude clouds. Observations of reflection-characteristics of radio signals on various wavelengths. Similar observations of the paths of sound waves caused by explosions. Correlation of this data with astrophysical data such as sun-spot frequency, the solar constant, cosmic ray intensity, etc. Theoretical study based on laws of magnetism, kinetic theory of gases, etc.

Cross-Section of Air

Figure 1 is a sketch cross-section of the earth's atmosphere based on the results of such work. Such a cross-section is never final, because new discoveries are constantly changing the hypotheses concerning the upper atmosphere. Yet it may serve to indicate the variety of the phenomena which occur in zones formerly thought of as so much empty space. No exact limit can be set at which these "cosmecological" phenomena cease. Jeans estimates that traces of atmosphere extend to an altitude of 2000 miles, while radio echoes have been observed from reflecting surfaces apparently beyond the orbit of the moon. Stormer explains this on the hypothesis of magnetic shields or fields extending from the earth for a distance equal to many times its diameter.

Proponents of the rocket are gratified at the dictum of many eminent scientists that exploration of these regions is of great and increasing value. It is very probable that before the rocket can earn its way commercially, it will be developed to a considerable degree solely to assist in research of this type. In fact, already the bulk of Dr. Goddard's work has this motivation.

While it is possible to hazard a guess at the equipment which a purely meteorological rocket will carry (see "Previewing the Aerological Rocket", **Astronautics** No. 36), such a forecast becomes almost impossible in the case of the "Cosmecological Rocket", because of the great range of the phenomena to be studied

In general, the instruments carried must be: Spectroscopes for sunlight, skylight, horizon light, etc.; electrometers; cosmic ray counters; air samplers; bolometers; magnetometers; instruments for measuring conductivity and ionization of air; radio transmitters for studying propogation of waves at high altitudes, etc., as well as the customary thermographs, barographs and hygrometers.

Much of the technique for constructing these instruments will have to be developed especially for rocket sounding. It is true that a good many instruments have already been built very light and compact for use with sounding balloons. Dr. R. A. Millikan has built a recording balloon electroscope weighing only .340 kilograms; Compton and Regener-Stuttgart have sent completely automatic cosmic ray counters weighing in the neighborhood of fifteen or twenty pounds aloft in unmanned balloons, and Dr. Abbot has done the same for bolometers in his study of variations in the solar constant. Light and effective air-samplers of various kinds have been in use for decades.

Problem of Rocket Instruments

But the rocket will attain its greatest altitudes only at the expense of very high speed. Once launched there is only an instant when it hangs motionless at the apex of its flight, and the total duration of the flight will be measured in seconds, or at most minutes. Parachutes will be useless at altitudes above ten or twelve miles. It will therefore be necessary to develop instruments capable of recording instantaneously while in rapid motion; and in place of single ascents lasting

for hours as in the case of present-day stratosphere balloons, there will doubtless be a series of probing shots spaced at suitable intervals over the required period.

Perhaps large rockets will be built carrying batteries of instruments for multiple observations, or perhaps in some cases it will be found more feasible to design a rocket around a single instrument.

For example, it has recently been suggested that in solar observations special rockets might be built equipped with photo-electric rather than gyroscopic control, such that they will fly always at a constant angle to the sun and so hold the lenses of their instruments in focus. Perhaps for some types of observation curved trajectories leading from one point to another will be better than vertical shots, for a rocket so fired will cover more area and its vertical motion will at the same time be slower.

No New Fuels Needed

It is not probable that for work of this type any propellants more powerful than the gasoline-loxygen mixture will be needed, for improvements in thermal efficiency by the use of regenerative motors, etc.; as well as increases in the fuel-load ratio made possible by pump feed, will enable rockets powered with gasoline-loxygen to rise to very great altitudes.

At the present stage of development it is of course impossible to foresee just how the many technical problems in connection with these sounding rockets will be solved. All that is certain is that the new science of cosmecology affords probably the most important justification for rocket research today, and its demands are sufficiently comprehensive to encourage the development of powerful and highly perfected machines.

PHOTOS FOR EXPERIMENTERS

There has been considerable demand from members and experimenters for enlarged photographic prints of the pictures in **Astronautics**, and a committee was appointed to study the matter.

As a result the Society has succeeded in making an arrangement with a large commercial photograph agnecy, by which it will be possible to provide sharp, clear glossy prints, enlarged uniformly to 5x7 inches, at $1 each or $10 for any 12 to members, $1.25 each or $12 a dozen to non-members, postpaid.

These photos are for the purchaser's collection only; they cannot be reproduced in newspapers or magazines without special permission.

Slides for Public Speakers

Experimenters who wish slides instead of photographic prints may order them from the Society at the same prices as quoted above for prints. The slides will be standard American size, made by the best commercial manufacturers.

Order either photos or slides from the Secretary of the American Rocket Society, 420 Lexington Avenue. Give the title of the photograph and the number and page of the issue of **Astronautics** in which it was reproduced. Money must accompany the order, either cash or check.

While it may not be possible in all instances, the Society will endeavor to provide on this basis prints or slides of all photographs published in this or past issues of **Astronautics**, and of future issues. Also, if the general plan meets with approval, **Astronautics** will list and describe, from time to time, additional photographs never published anywhere that are available as prints or slides.

THE ROCKETOR'S WORKSHOP

A Department Devoted to Shop-talk, Ideas, Devices

Practical experimenters are invited to contribute to this new department. Articles should be kept brief, to the point, non-theoretical. They should be accompanied by suitable drawing or photograph.—Ed.

CONSTRUCTION OF TANKS— No Matter How Large, Cubic Capacity Per Pound of Tank Remains Constant

In general, the design of rocket tanks follows the rules laid down by good engineering practice as applied to all pressure vessels. However, a rocket tank differs from other pressure vessels in one important respect. The drastic weight economy, imposed by the conditions of the problem, requires us to reduce the safety factors to the very minimum and to adopt the most economical shape for our tanks.

A study of the underlying theory brings out one surprising fact, namely that no matter how large or how small a tank we may build, its cubic capacity per pound of weight of the structure will remain constant, provided other conditions remain the same. There is no scientific basis for the popular impression that we can make the tanks of a large rocket carry more fuel in proportion to their weight than those of a small rocket.

Tank Calculation

Let us first consider a sperical tank, since a sphere is the most economical shape for a tank that can be adopted. For the purpose of this discussion we shall assume a seamless sheet metal sphere without fittings.

Let:

V = capacity of the tank in cubic inches

R = radius of the tank in inches

P = internal pressure (pounds per sq. inch)

F = stress in the metal (pounds per sq. inch)

D = the density of the metal (pounds per cubic inch)

W = the weight of the tank in pounds

H = the height of the vertical wall in a cylindrical tank

We know from a study of the strength of materials that the required wall thickness in a spherical shell subjected to internal pressure is:

$$t = \left(\frac{P\,R}{2\,F}\right)$$

Now the capacity of the tank is equal to the volume of the sphere:

$$V = (4/3)\ \pi R^3$$

therefore, $R^3 = (3V)/(4\pi)$

and the surface of the sphere will be $= 4\pi R^2$

then $W = 4\pi R^2 tD$

or $W = (2\pi R^3 PD)/F$ (substituting for t)

or, substituting for R:

$$W = V\ 1.5\left(\frac{PD}{F}\right)$$

which shows that the weight of the tank is a linear function of the volume, all the figures within the brackets remaining constant for a given set of working conditions. In other words, the weight-capacity ratio of spherical tanks is a constant regardless of size.

Tank Shapes

Now a spherical tank is not an easy one to build, nor a convenient one to handle. In practice cylindrical tanks are generally used. The ends of such tanks are commonly dished, or given the form of a portion of a sphere with

the radius of curvature equal to the diameter of the cylinder. When that is done, the tension in the metal is the same in the end plates as in the walls of the cylinder, and metal of the same thickness may be used throughout. This is very desirable, since it economizes on the material and does away with the need of stay-bolts.

The weight per volume of a cylindrical tank will depend upon its shape, or rather upon the H/R ratio.

We can vary this ratio at will from zero to infinity, although in practical tanks this ratio would fall between 2 and 10, with, say, 5 as a fair average condition.

The weight of any tank can be calculated by the following equation:

$$W = \left(\frac{VPD}{F}\right)\left(\text{Form Factor}\right)$$

The form factors for cylindrical tanks with dished heads with a radius of curvature equal to the diameter of the cylinder are given in a table below. The reader can easily check the derivation of the formula, and form factors, by a method of reasoning analogous to that used for spherical tanks.

H/R ratio	Form Factor
0	7.8
2	2.7
5	2.3
10	2.15
Infinity	2.0

This offers a very useful method for making preliminary calculations in rocket design, since we do not have to know the physical dimensions of a tank to estimate its weight. A large number of possible designs may be checked without the loss of time required by the ordinary methods. It is understood, of course that these formulas neglect such details as fittings, seams, etc.

Tank Materials

Rocket tanks have been made of various materials, such as alumnium, brass, copper, or steel, depending on conditions and the designer's fancy.

In general, aluminum alloys are preferable to other materials, because lighter tanks may be made from commercially available alloys. On the other hand the welding of aluminum requires the services of skilled professional welders to be executed properly. Where these are not to be had, it may be necessary to use copper or brass tanks, which will somewhat increase the weight of the rocket, but will certainly facilitate the construction work.

The end plates are shaped with a hammer over a stake, the edges are turned down to form a lip, which should make a snug fit with the tube which forms the cylindrical part of the tank. The fittings are first silver soldered into the end plates, and then the end plates are in turn silver soldered to the tank. Soft solder (lead-tin alloy) has not sufficient strength for high pressure work, and should never be used in tank construction.

Whatever the material decided upon, our selection should be governed by commercially avaliable shapes and sizes. A piece of seamless tubing should be used for the body of the tank, since forming it out of sheet metal introduces a longitudinal seam which is very undesirable.

Some consideration should be given to the method of attaching the tanks to each other and to the rest of the rocket structure. This will of course depend upon the design of the particular rocket beng bult. One method is to make the end plates fit inside the tank and about one inch below the ends of the cylinder, (Fig. 1) so that the projecting rims make a convenient place for connections. Other-

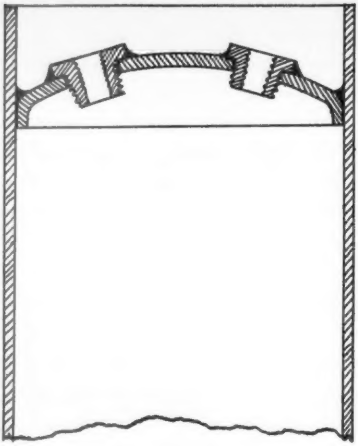


Fig. 1

wise lugs or other projections, welded to the tanks, may be made to serve the same purpose. (Fig. 2) In some cases, as in two-stick "Repulsor" type of rockets, the tanks are merely held together by clamps or metal bands.

Fittings

The fittings in the case of brass or copper tanks are brass I. P. S. reducing bushings of the requisite size, silver-soldered into the tank ends. In case of aluminum tanks the same procedure is used, except that aluminum fittings are welded into the cover. The fuel tank will require two fittings, namely, one for the feed tube and one for the filling hole. In rockets of ½ inch nozzle throat diameter both of these may be of ⅛ inch pipe size, so that ⅛ by ¼ inch bushings should be used.

A Schrader tire valve, provided with a pipe thread at its base. is used as a plug for the filling hole, and also serves as a check valve for applying the nitrogen pressure to the tank. It may be well to point out in this connection that a specially constructed hand operated needle valve would perhaps be preferable to a tire valve, especially when pressures much above 350 pounds per sq. inch are to be used.

The fittings on the oxygen tank are the same except that it is well to use larger sizes throughout. Liquid oxygen tends to boil vigorously and to flash into vapor upon contact with any surface at room temperature, so that considerable difficulty is always experienced in filling an oxygen tank. The filling hole should be no smaller than ⅜ inch pipe thread. A safety valve is made to screw directly into this hole. A vent hole with a valve should also be provided, to serve as a vent while the safety valve is being screwed home, otherwise it is very difficult to catch the thread against the pressure developed by the boiling oxygen.

As a safety measure, all tanks should be tested after completion, in order

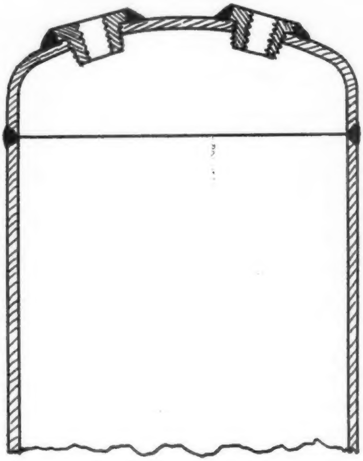


Fig. 2

to guard against disastrous explosions. To test a tank it should be filled with water, and the pressure should be applied by means of a hydraulic pump. A tank in order to be safe should be able to sustain one and a half times the contemplated working pressure without leaks or any serious bulging of the walls. It is always advisable, though not absolutely necessary, to make up a short sample tank out of the same tubing from which the regular tanks are to be made. This small tank can then be tested to destruction to determine its ultimate strength. In conducting such a test it will be found that as the pump is worked, the pressure rises steadily up to a certain point, namely the yield point of the material. When that is reached, the pressure will not rise any more as the pump is worked, but the walls of the tank continue to expand at a constant pressure. Finally the tank will burst at some point, which will be indicated by a spray of water.

—John Shesta

Notes and News

(Continued from Page 2)

Mr. Jack Parsons of the Halifax Powder Company, and others, has begun experimental rocket motor studies. Preliminary tests have already been run with motors burning gaseous oxygen and methyl alcohol on a simple proving stand equipped with a thrust-recording drum. Plans are under way for a complete testing laboratory.

Mr. Malina and A. M. O. Smith reported on some of this work last week before the Institute of the Aeronautical Sciences, in a paper entitled "Flight Analysis of the Sounding Rocket".

Dr. William Bollay, of the same institution, is conducting extensive theoretical studies of the performance characteristics of rocket-propelled air craft.

BRITISH EXPERIMENTERS encounter, in addition to the usual obstacles of rocketry, a law, the Explosive Act of 1875, which throws further hazards in the path of rocket development in England. Subsequent to some experiments at Clayton Vale, near Manchester last March, Eric Burgess, President of the Manchester Interplanetary Society, was summoned before the Manchester Police Court to answer a charge of contravening the Explosives Act.

According to the **Bulletin** of the British Interplanetary Society, the case was adjourned until June 14, and on that date the charge was withdrawn after Mr. Burgess had been cross-examined in the witness box for two hours, and had agreed not to use potassium chlorate and sulphur in combination in any future experiments.

"While the Manchester group is in no way connected with the BIS, although the names are similar," remarks the Bulletin, "members will no doubt congratulate Mr. Burgess upon talking so scientifically to the judge."